Report as of FY2009 for 2009VT45B: "Estimating Soil Phosphorus Concentrations along Erodible Stream Corridors in Chittenden County, Vermont "

Publications

- Other Publications:
  - Garcia, Angel, 2010, Understanding the Relationships between Beaver Dams and the Movement of Phosphorus through Allen Brook, Chittenden County, VT, Universidad Metropolitana 2nd Annual Vermont EPSCoR Streams Project Symposium, Apr 19, 2010 Burlington, VT.
  - Thomas, Maya, 2010, Riparian soil phosphorus and stream channel migration at Allen Brook in Chittenden County, VT, UVM Student Research Conference, April 22, 2010, Burlington, VT.
  - Alves, Caroline, 2010, Examining phosphorus contributions from alluvial soils - a comparison of three Vermont river corridors, (USDA-Natural Resources Conservation Service). Lake Champlain 2010 Conference: Our Lake, Our Future, Lake Champlain Research Consortium, June 7-8, 2010, Burlington, VT.
  - Young, Eric, Don Ross, Caroline Alves, and Thomas Villars, 2010, Spatial variability of riparian soil phosphorus at a site along the Rock River, Vermont, Lake Champlain 2010 Conference: Our Lake, Our Future, Lake Champlain Research Consortium, June 7-8, 2010, Burlington, VT.

Report Follows

Interim Progress Report

Title: Estimating Soil Phosphorus Concentrations along Erodible Stream Corridors in Chittenden County, Vermont

Project Type: Research

Focus Categories: Nutrients, Nonpoint source pollution, water quality

Research Category: Water Quality

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Congressional District: Vermont-at-large

Abstract

Phosphorus (P) loss from stream bank erosion is thought to be a major and underestimated contributor of P loading to Lake Champlain. Soil variability strongly influences the chemical and physical properties of riparian areas. Results from our recent research funded by the UVM Water Resources and Lake Studies Center demonstrated that riparian soil P concentrations varied significantly by soil type, texture (e.g., sand, silt, and clay distribution), and drainage at three riparian sites in the Lake Champlain Basin (Lewis Creek, Rugg Brook, and Rock River), suggesting that detailed soil maps may be used to estimate P concentrations. Parent material and drainage vary widely in Vermont's riparian landscapes, making it difficult to produce accurate soil maps. Since drainage and texture are the two main factors that determine soil types, traditional and novel mapping techniques show promise for estimating riparian soil P availability. Building on our previous research, this project will combine high-order soil mapping and soil testing to estimate P levels at riparian sites in Chittenden County, VT. This approach will generate soil-specific P concentrations for each of the study sites. Year one of the project focused on sampling along Allen Brook and Indian Brook, where historical channel migration measurements have occurred. In year two, we will sample along two attainment streams, Alder Brook and the upper reaches of the LaPlatte River. Both are undergoing detailed stream bank erosion mapping by co-investigators Morrissey and Rizzo. We will target two types of erosion features: i) those with the same soil series as the year-one samples and ii) other important stream corridor soil series that were underrepresented in year-one sampling. Using our accumulated dataset, we will evaluate the applicability of our approach to other stream corridors in VT by how well soil type and other properties predict P concentrations in the year-two samples from the same soil series. When coupled to historical measurements of streambank erosion, results from this project will provide improved estimates of P mobilized by fluvial systems and contribute to a greater understanding of P dynamics in the Lake Champlain Basin.

Results from Year 1.

During the first field season, sampling was performed along two streams in Chittenden County that had been identified as impaired. Areas of active erosion were identified via remote sensing by co-investigator Morrissey. On each stream, 25 locations were randomly selected for sampling. All remotely identified features were first verified by a site visit. We then sampled the selected features 1.5 m in from the 'outer' (non-eroded) bank. At each site, three soil corings were taken 1 m apart, with four depths collected: 0-15 cm, 15-30 cm, 30-60 cm and 60-90 cm. These depths were selected to provide P concentrations for the upper soil layers that may reflect

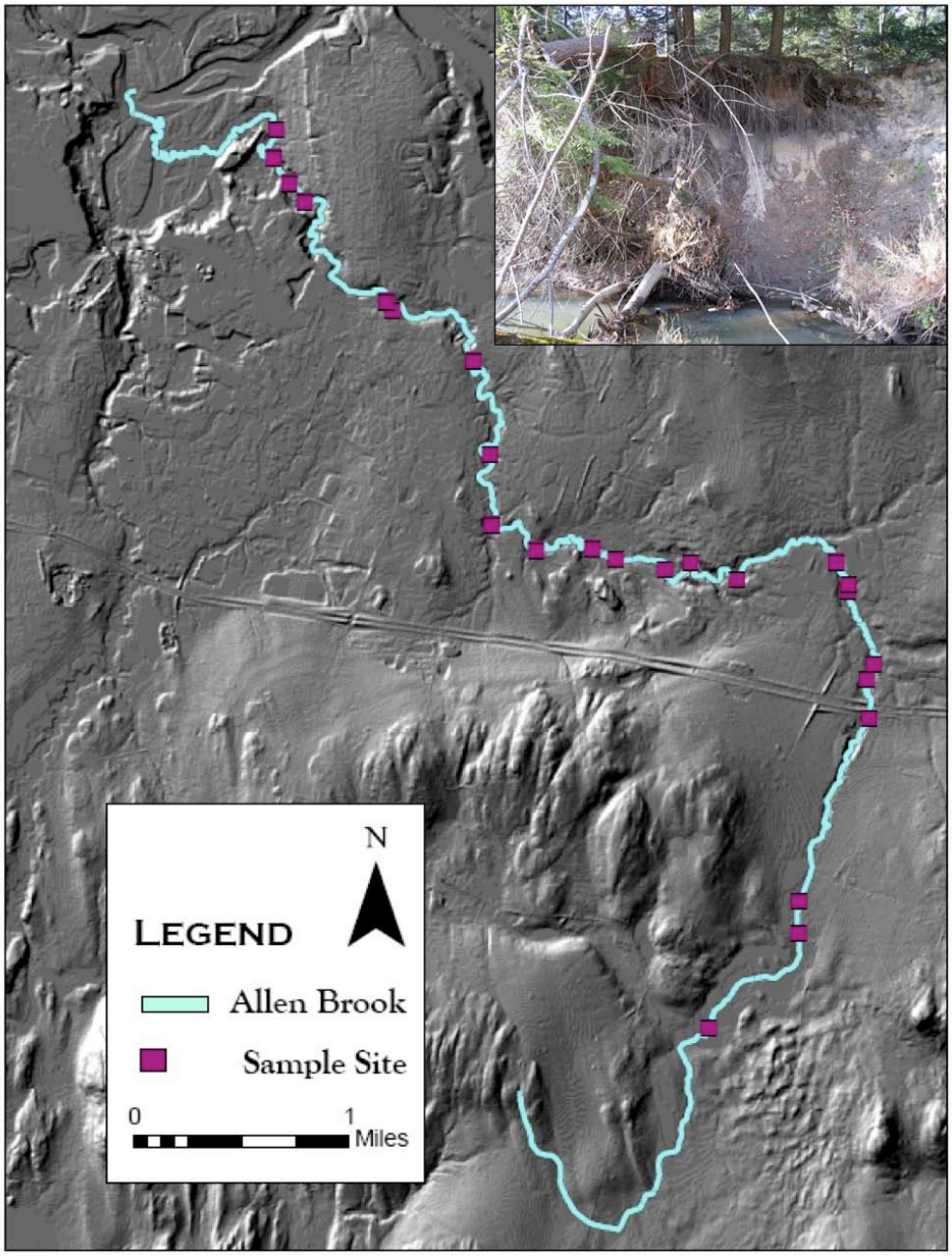

Figure 1. Map of Allen Brook sample sites. 24 out of 25 sampled. (Figure prepared by Eulaila Ishee.)

historical land use and also for lower soil layers that are representative of soil parent material. This approach resulted in 12 samples per feature unless sampling was impeded by coarse fragments or bedrock. Bulk density cores were also taken with a Uhlander device at two depths (0-15 and 15-30 cm) adjacent to each coring. All soil sampling locations were georeferenced to ensure a match with the remote sensing data. As of 05-12-10, 24 sites have been sampled along Allen Brook (Fig. 1) and 14 sites sampled along Indian Brook (Fig. 2) for a total of about 470 soil samples for chemical tests and 228 samples for bulk density and coarse fragment measurements. In addition to this sampling, we dug five classification soil pits along Allen

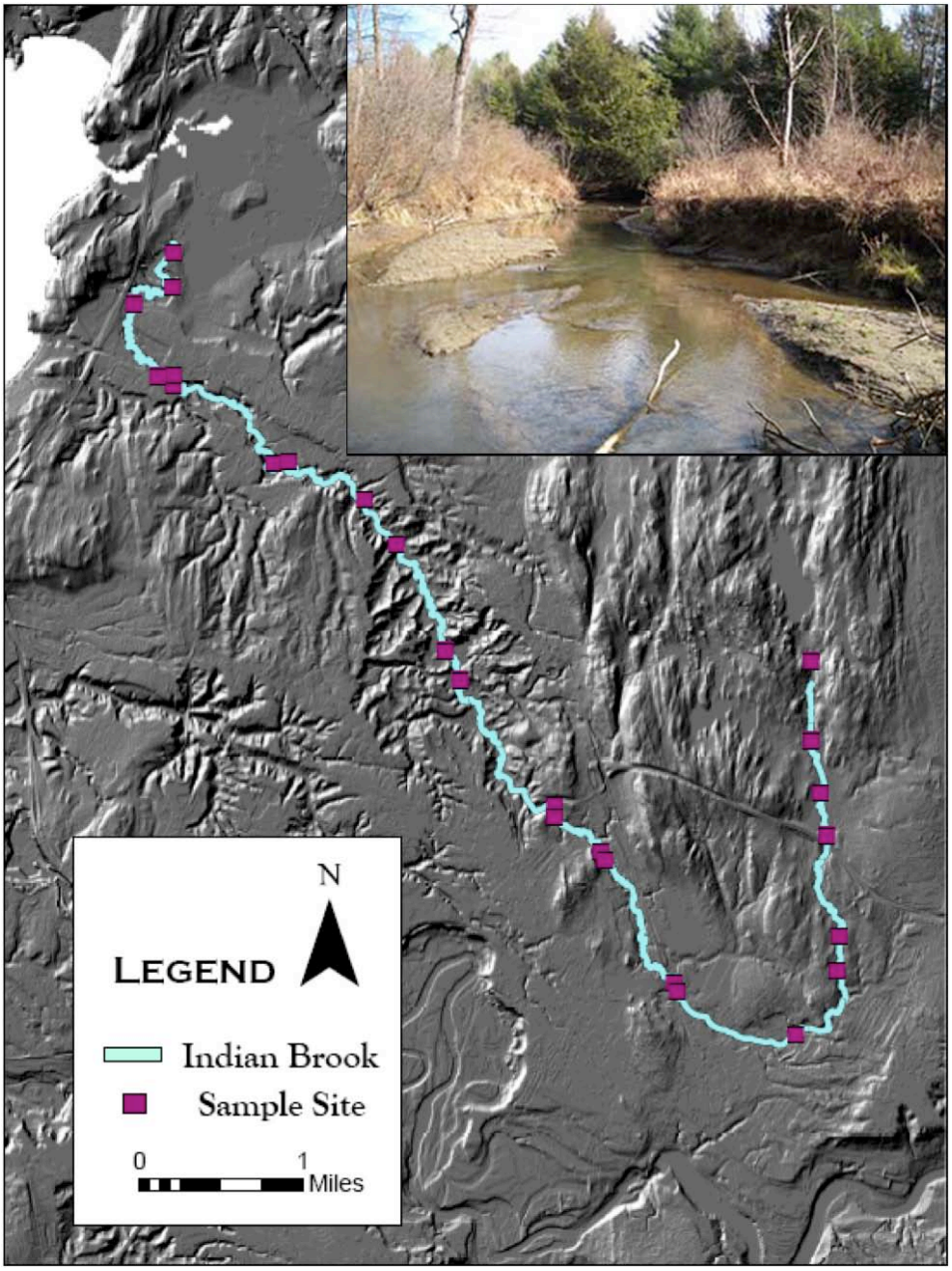

Figure 2. Map of Indian Brook sample sites. 14 out of 25 sampled. (Figure prepared by Eulaila Ishee.)

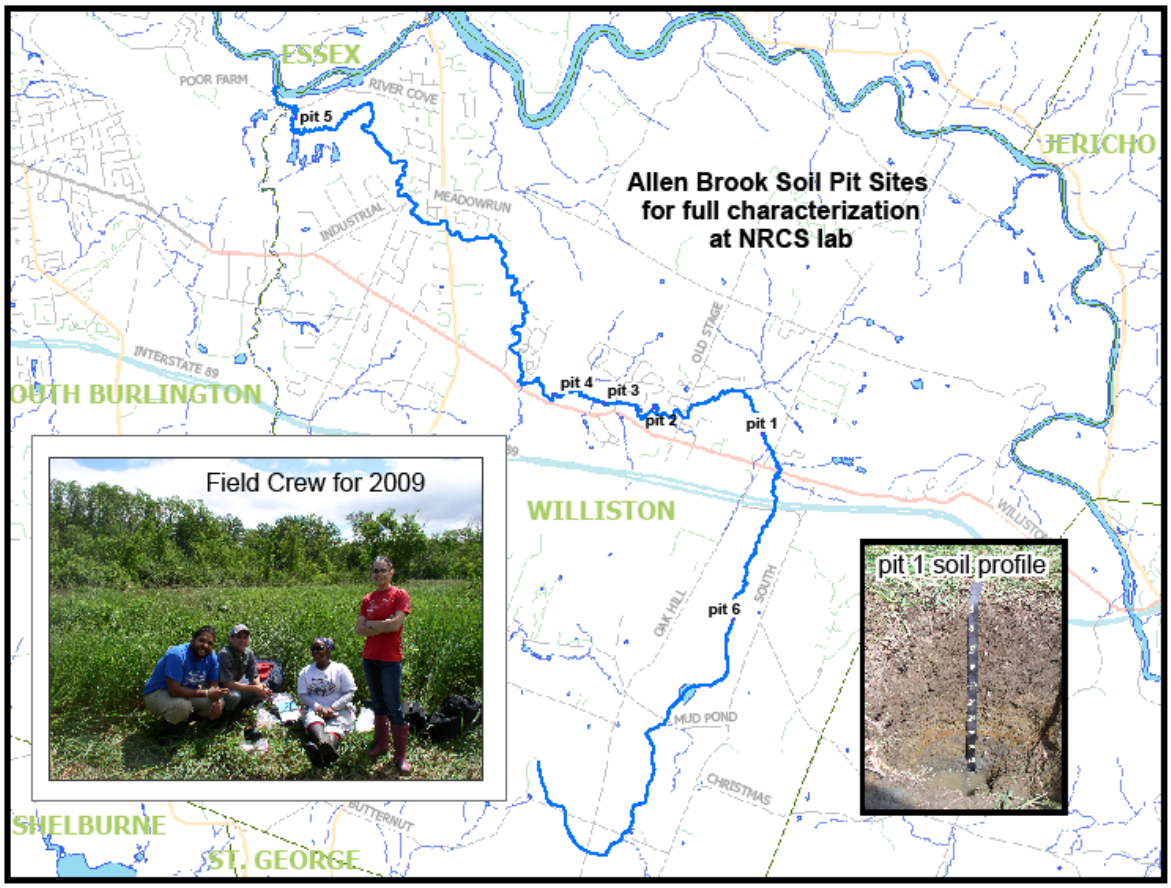

Figure 3. Location of the characterization soil pits. Field crew for the summer of 2009, left ot right, Angel Garcia, Edward Garcia, Maya Thomas and Rebecca Bourgault. (Figure prepared by Caroline Alves, Vermont NRCS.)

Brook in collaboration with cooperator Caroline Alves of the USDA NRCS (Fig. 3). Samples from these pits have been sent to the National Soil Survey Lab for complete physical and chemical analysis, and the data will be used to definitively classify the sampled soils. In these pits, we also obtained bulk density samples from the lower depth increments that are being analyzed at UVM. Finally, at locations where the streambank exceeded 1 m in height and was exposed, we took additional depth increments by digging directly into the bank. These samples will be used to determine if soil changes take place at these greater depths.

Laboratory analyses. For samples analyzed to date, Tables 1 and 2 give the mean and range of chemical characteristics. The range in soil-test or 'available' P, which has been found to correlate well with algal-available P, was relatively broad but the means for each depth were below the optimum range for crop growth (4-7 mg/kg colorimetric P). We found similar low soil-test P in our previous USGS-funded studies of stream corridor soils in Franklin and Addison counties. In our initial Allen Brook results, soil pH was usually somewhat acidic and, coupled with the moderate amounts of available Al, it is likely that these soils would be P sinks if not eroded. Total P has not yet been determined but, based on our previous studies, will be at least

two orders of magnitude higher. The highest Ca, pH and Mn values were all deep in the profile and probably reflect a partially weathered limestone parent material.

Depth cm	P-ICP[1] mg/Kg	P-color[2] mg/Kg	pH mg/Kg	% LOI[3] mg/Kg	Ca mg/Kg	Al mg/Kg	Fe mg/Kg	Mn mg/Kg
0-15	4.4	2.9	5.7	4.3	1206	45.6	19.4	16.5
15-30	2.5	1.5	5.7	2.7	1222	77.3	19.6	13.8
30-60	1.7	1.2	5.8	1.7	1304	47.7	13.4	13.8
60-90	2.4	1.8	5.8	1.6	451	34.0	12.8	7.9
Overall average[4]	2.8	1.9	5.8	2.7	1100	52.7	16.6	13.5
min[5]	0.5	0.4	4.0	0.2	71	4.2	1.8	0.9
max	11.9	9.9	7.6	8.8	6504	323.3	111.2	75.4

[1] 'Available' phosphorus by ICP-OES (includes inorganic and organic)

[2] Colorimetric 'available' phosphorus (inorganic)

[3] Estimate of organic matter by weight loss on ignition

[4] Overall averages are from the means of each sample site

[5] Min and max of averaged values

Table 1. Summary of soil test results from the Allen Brook sampling (*n* = 153). The extractant was pH 4.8 ammonium acetate (Vermont's soil test procedure).

Soil texture of soils along the erodible features on Allen Brook was a mixture of sandy loams and loamy sands (Tables 2 and 3). There was often a general increase with sand at depth in the profile. Both the texture and the texture change are typical of the soil series mapped in this area. Not all sites were sandy however—one erosion feature had silty clay loam soils, giving the minimum value for sand (22.3%) and the maximum for clay (28.9%) and near the maximum for silt (48.8). More than half the samples analyzed to date have been sandy loams (Table 3).

Sample Depth cm	Sand %	Silt %	Clay %	Bulk Density mg/m^3	Coarse Fragments vol%
0-15	56.5	34.6	8.9	1.01	2.8
15-30	57.4	33.2	9.5	1.20	2.0
30-60	64.6	27.5	7.9	nd[1]	Nd
60-90	64.1	34.6	8.9	nd	Nd
overall average[2]	60.3	31.3	8.4	1.41	2.4
min[4]	22.3	4.8	2.4	0.48	0
max	91.9	49.8	28.9	1.72	18.1

[1] Not determined

[2] Overall averages are from the mean of each erosion site

[3] Coarse fragment overall average is the mean of all values

[4] Min and max of averaged values

Table 2. Physical characteristics from initial soil analysis of the Allen Brook samples (*n* = 97).

Texture Class	#	%
loam	19	0.20
loamy sand	16	0.16
sand	6	0.06
sandy loam	52	0.54
silt loam	2	0.02
silty clay loam	2	0.02
total (n)	97	1.00

Table 3. Number and percent of individual samples by texture class (n = 97).

Ongoing schedule

In year two, we will finish the Indian Brook sampling in late spring and, between June and August, sample an additional remotely-sensed erosion features from Alder Brook and the LaPlatte River. Additional characterization soil pits will be located along Indian Brook and at other locations that match the needs of the NRCS (specific soil series). The final six months of the project will focus on laboratory analysis, statistical analysis and soil map updating.

In an associated project, co-investigators Morrissey and Garvey (and collaborator Rizzo) are performing the remote sensing analyses of channel migration for streams in Chittenden County. As it becomes available, we will supply phosphorus and bulk density data so that historical P loading into the streams can be calculated. Calculation of P loading in other Chittenden County streams will follow once we better understand the variability of bulk density of P content, and their relationship to soil series characteristics, such as texture and drainage.

Training

This project is training a M.S. candidate (Eulaila Ishee) in all aspects of the proposed research. In additional, the project is providing valuable training for a number of undergraduate students majoring in Environmental Sciences and student interns in UVM STREAMS program. During the first field season we had the help of two students (Edward Garcia and Angel Garcia) from Universidad Metropolitana of Puerto Rico as part of the UVM STREAMS internship program. We also had the assistance of a UVM McNair scholar from the Rubenstein School, Maya Thomas. These three students have already given presentations on the research they performed last summer. Most recently, Angel Garcia presented at the annual STREAMS conference and Maya Thomas at the UVM Student Research Conference (citations below). In addition, Angel has been admitted to UVM's graduate program in the Geology Dept. and will commence studies in the fall of 2010. For the second field season (2010), we will again have the assistance of two students from Universidad Metropolitana and one UVM Environmental Sciences undergraduate.

Conference Presentations

Two of these were student presentations and two will be presented at the upcoming Lake Champlain conference. The latter two are focused on earlier, related work in Lake Champlain stream corridors funded by the USGS Water Center and the VT ANR.

Understanding the Relationships between Beaver Dams and the Movement of Phosphorus through Allen Brook, Chittenden County, VT. Angel Garcia. Universidad Metropolitana 2nd Annual Vermont EPSCoR Streams Project Symposium, Apr 19, 2010 Burlington, VT.

Riparian soil phosphorus and stream channel migration at Allen Brook in Chittenden County, VT. Maya Thomas. UVM Student Research Conference, April 22, 2010, Burlington, VT.

Examining phosphorus contributions from alluvial soils - a comparison of three Vermont river corridors - Caroline Alves (USDA-Natural Resources Conservation Service). *Lake Champlain 2010 Conference: Our Lake, Our Future*, Lake Champlain Research Consortium, June 7-8, 2010, Burlington, VT.

Spatial variability of riparian soil phosphorus at a site along the Rock River, Vermont - Eric Young (University of Vermont), Don Ross, Caroline Alves, and Thomas Villars. *Lake Champlain 2010 Conference: Our Lake, Our Future*, Lake Champlain Research Consortium, June 7-8, 2010, Burlington, VT.